

High Contrast Imaging with MMT/Clio and the 6pc Survey

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*Clio PI: **Phil Hinz***

Clio Team: P. Hinz, A. Heinze, S. Sivanandam

*6pc Survey: **D. Apai**, M. Meyer, P. Hinz, M. Kasper/ESO, A. Heinze*

*Young Suns Survey: **A. Heinze**, P. Hinz, S. Sivanandam, M. Meyer*

*White Dwarfs Survey: **S. Sivanandam**, P. Hinz, M. Meyer*

MMT/AO Team: M. Kenworthy, D. Miller, P. Hinz



MMT and the Adaptive Secondary

AO Correction better at longer wavelengths

Thermal background lower at shorter wavelengths

MMT's adaptive secondary **integrates**
the AO into the telescope

10 vs. 2 warm surfaces, 550Hz, Shack-Hartmann WFS, 56
Zernike modes corrected (e.g. Brusa et al. 2003)

High-order correction +
very low thermal background

(H Strehl 25%, M Strehl 85%, Miller et al. 2004)

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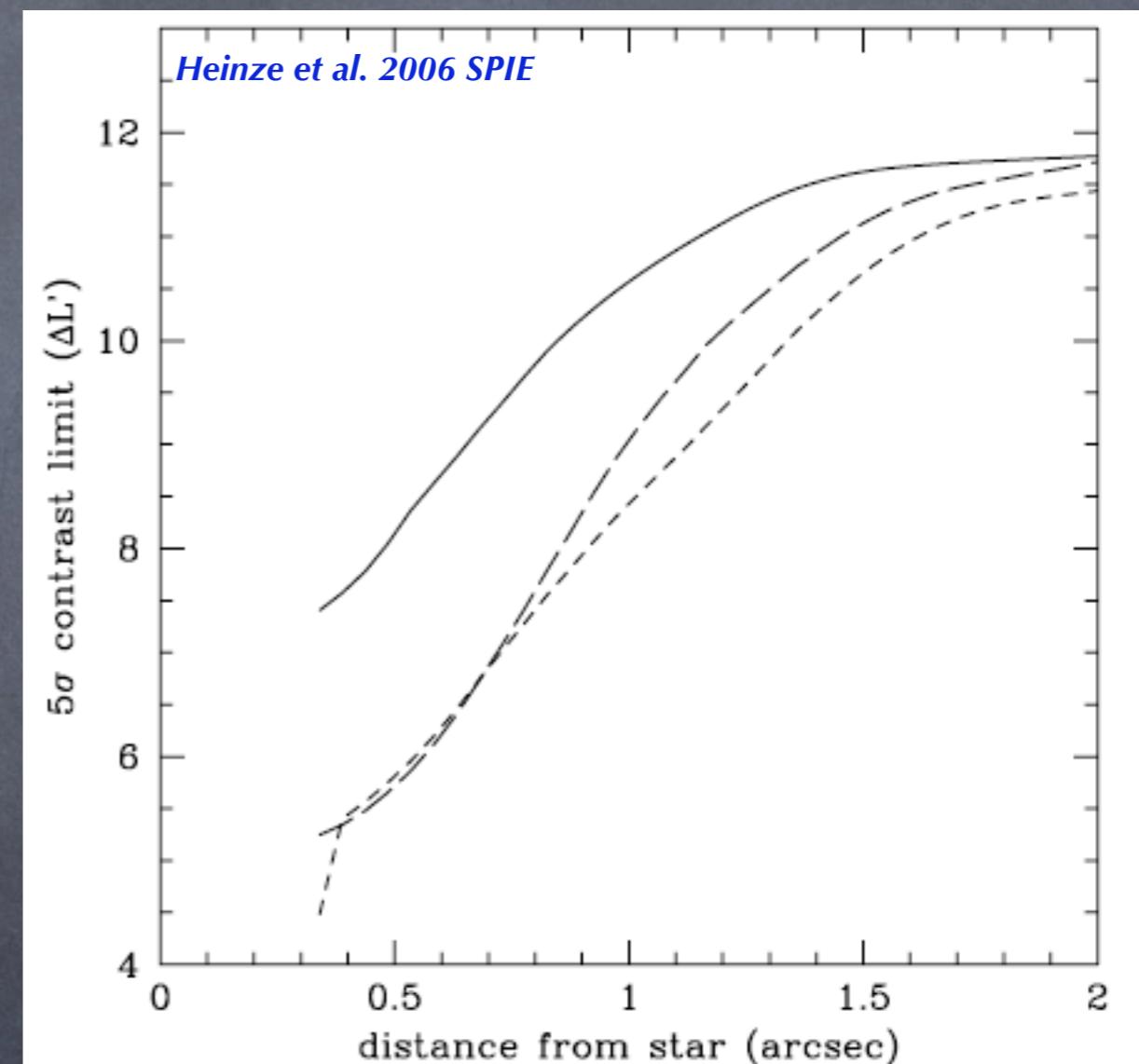
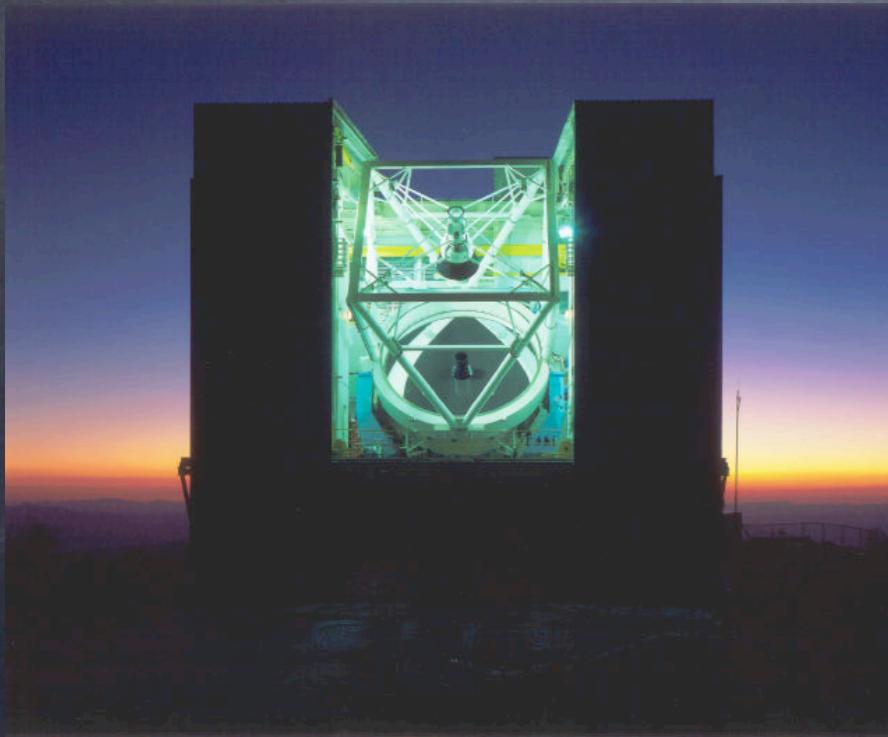
Clio: 3-5 micron imager

Cassegrain f15 reimaged to f20
InSb detector (320x256 pixels)

50 mas/pixel

Read out at 20 Hz

Freed et al. 2004 SPIE

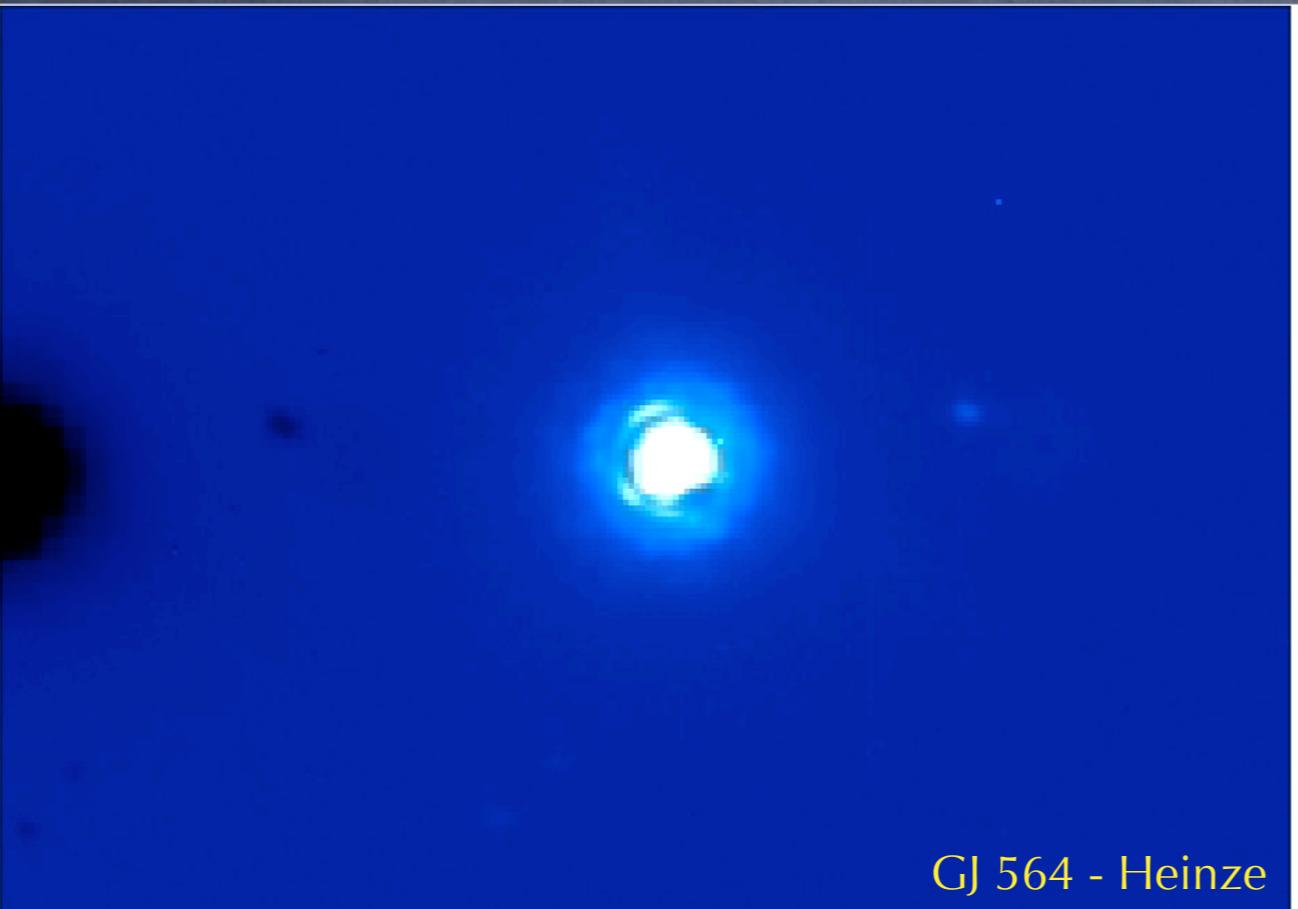


Major Effort at the MMT: Total of 32+ nights allocated already

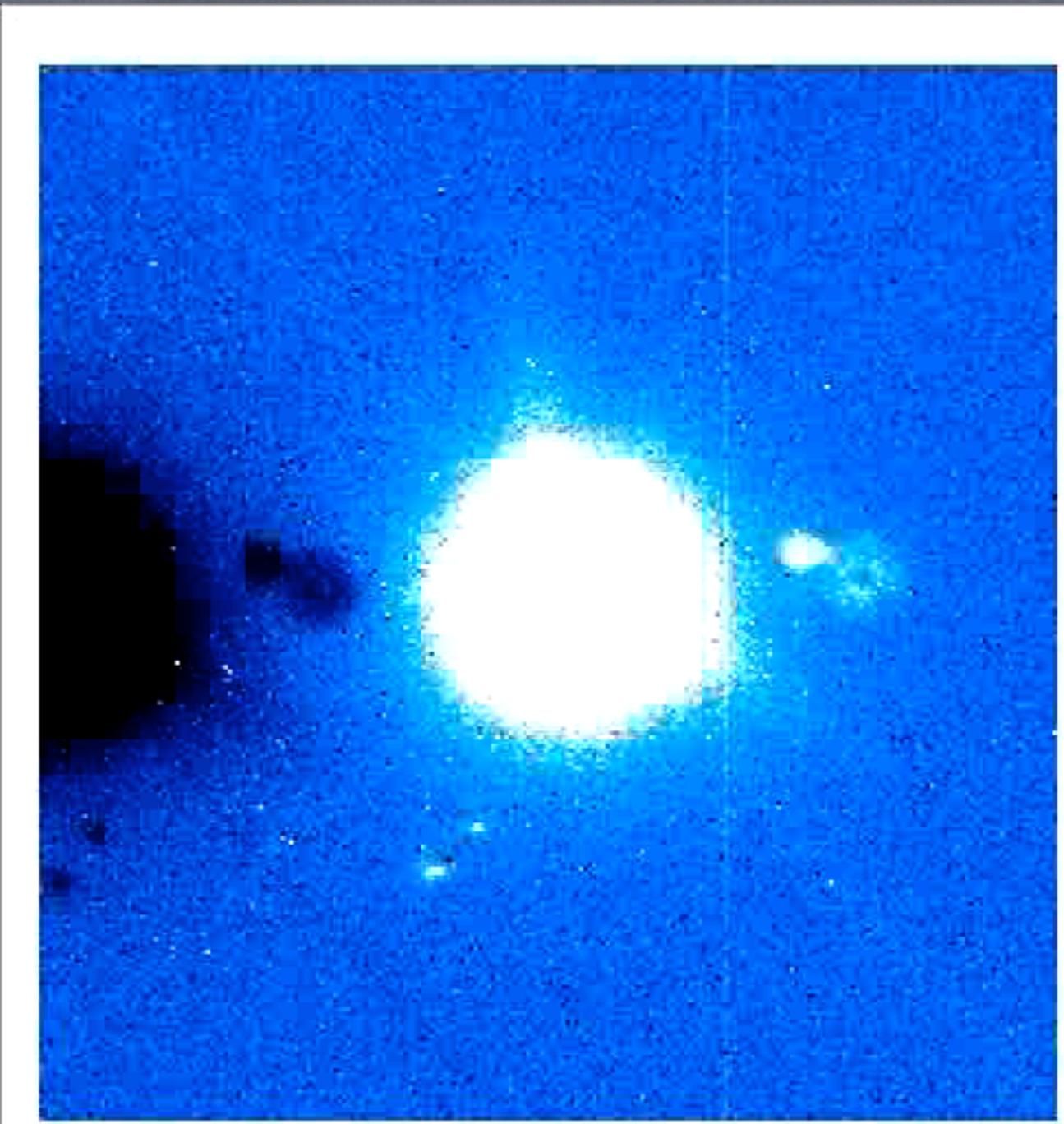
Angular Differential Imaging

Optical ghosts & persistent speckles stay fixed with respect to the telescope;
high contrast achievable (e.g. Marois et al. 2006, Kasper et al. 2005, 2006)

MMT/Clio
Data on GJ 564 from Heinze et al.



GJ 564 - Heinze



TPF/DARWIN Workshop - Nov 2006 - D. Apai

Vega and The Surveys

First Results:

Vega

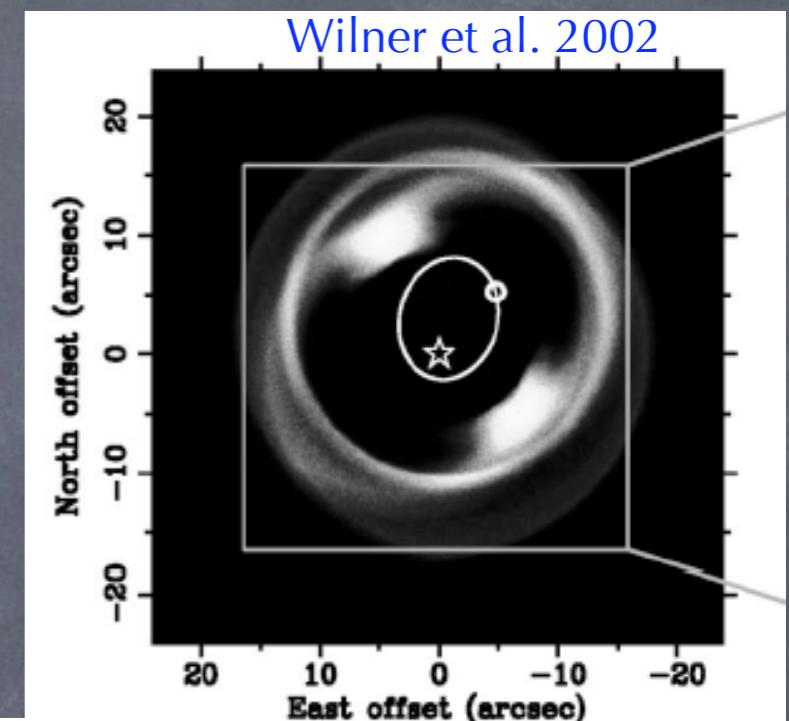
Upper limit: $7 M_{Jup}$ @ $2.5''$

$0.8 \text{ mJy} = 13.3 \text{ mag}, 300 \text{ Myr}, 7.8 \text{ pc}$

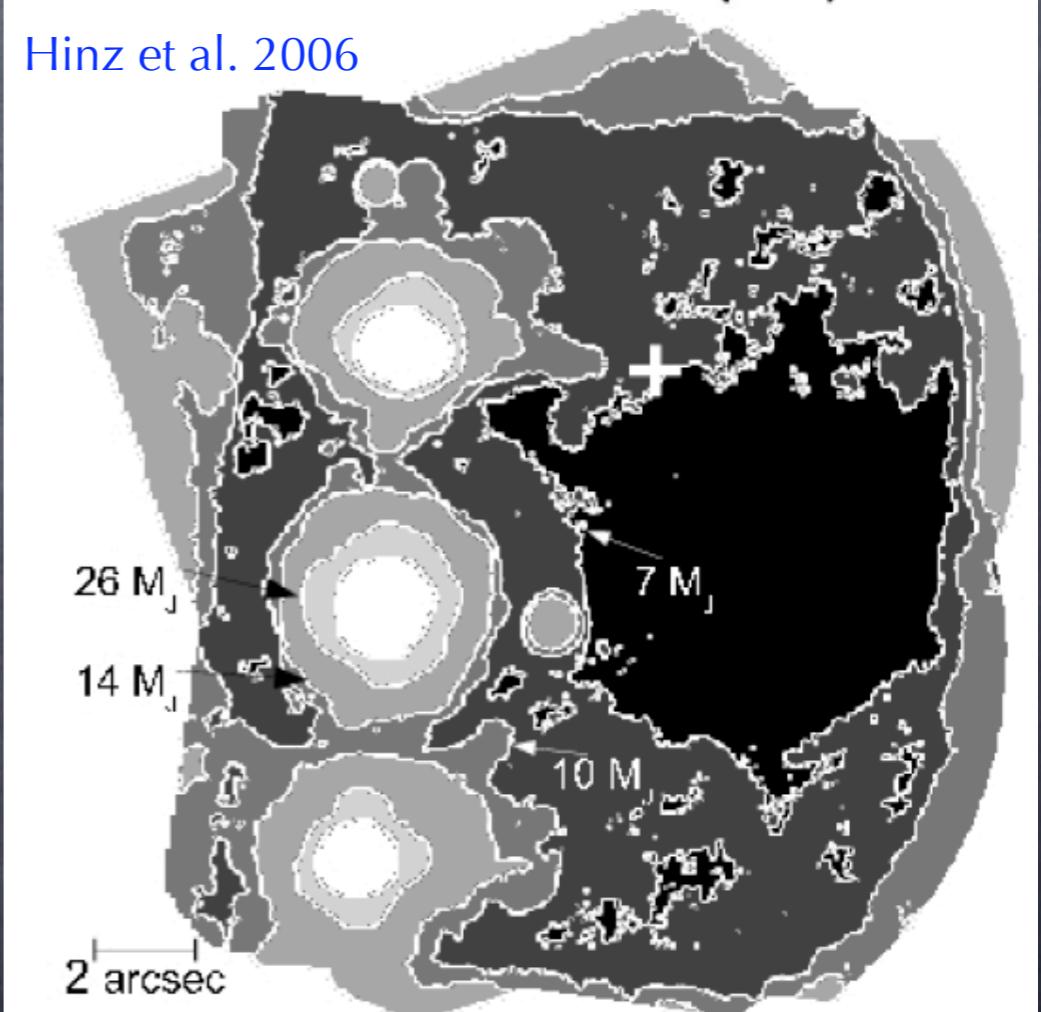
Hinz et al. 2006 ApJ, in press

Surveys:

1. Young Suns Survey
2. White Dwarfs Survey
3. 6pc Survey



Hinz et al. 2006



Young Suns Survey

A. Heinze, P. Hinz, S. Sivanandam, D. Apai, M. Meyer + MMT/AO Team

Goals:

FGK early M (similar to RV samples)

Dist. < 25 pc

10 M_{Jup} sensitivity

Status:

20 nights / 7 good

23/50 stars observed

8 companion candidates

6 background stars

2 physical companions

(1 known)

Heinze et al. 2006 SPIE

Heinze et al. 2007 in prep.

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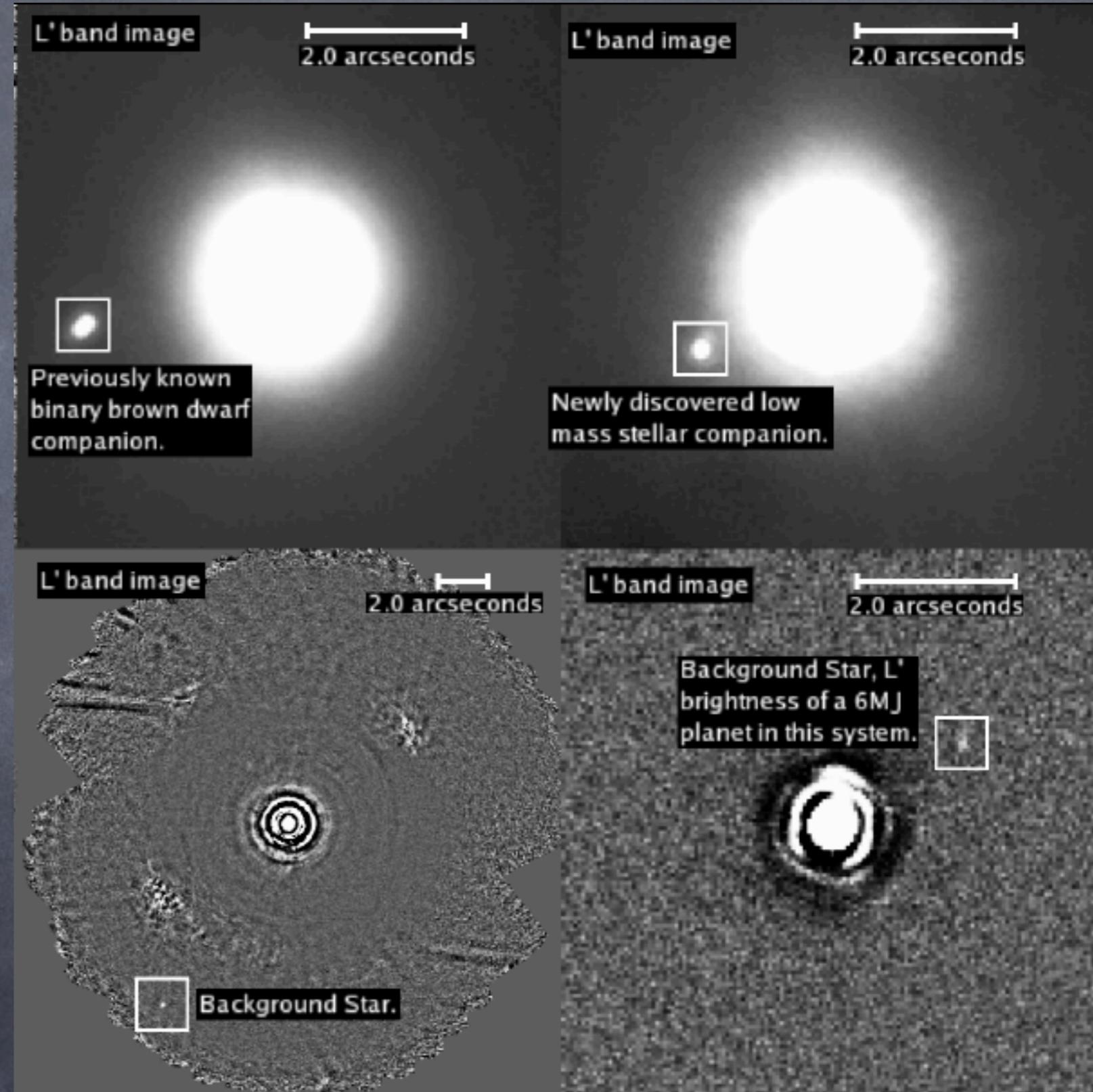
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The 6pc Survey

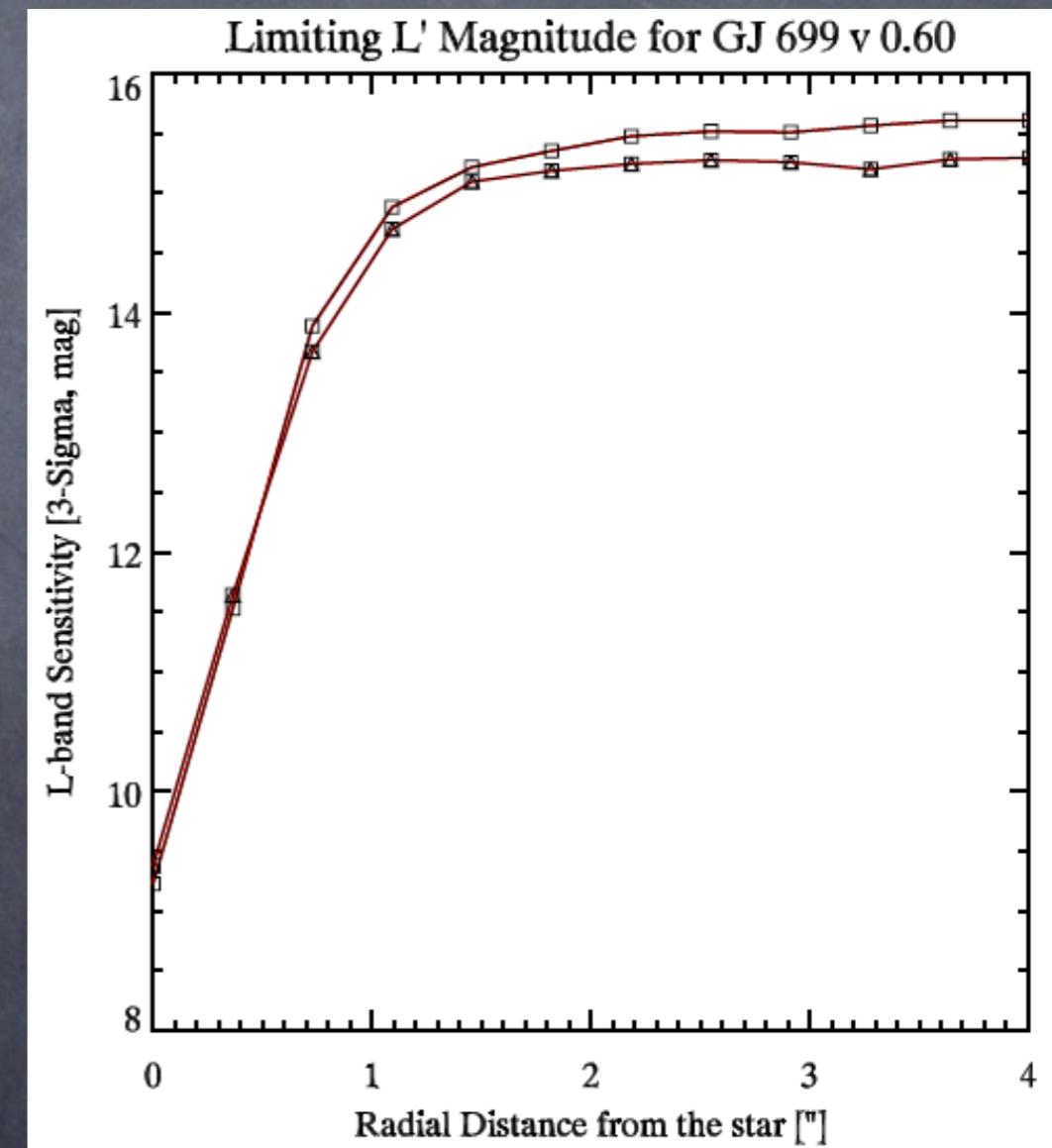
D. Apai, M. Meyer, P. Hinz, A. Heinze, M. Kasper + Clio Team + MMT/AO Team

1. (Some of the) most sensitive observations from the ground ($1''$ - $5''$)
2. L' band allows efficient detection of older planets: $5 M_{Jup}$ in a 2 Gyr system at 4pc

Goals: all 92 stars within 6pc - probe 2-30 AU

Status: 12 nights allocated on MMT;
VLT/NACO proposal pending

Allows the *most sensitive survey of the Solar neighborhood for planets and planetary-mass brown dwarfs on Solar System scales (3-20 AU $\sim 1''$ - $4''$)*



Cool Planetary Systems

M-stars: The most common planet hosts?

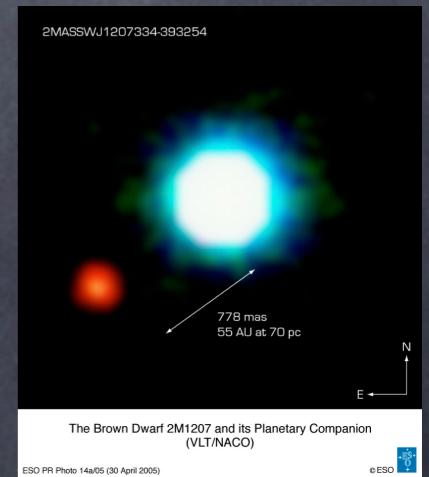
Cool Stars harbor *two* populations of planetary-mass objects:
Planets + Planetary-mass BDs

Constraints from $RV < 3$ AU
NIR Imaging > 30 AU
Microlensing $\sim 3\text{-}10$ AU (some)

Interesting scales:
2-20 AU, achievable only for
the closest systems

Southern stars
with NACO

(Kasper, Apai et al. 2005;
Kasper et al. 2006)



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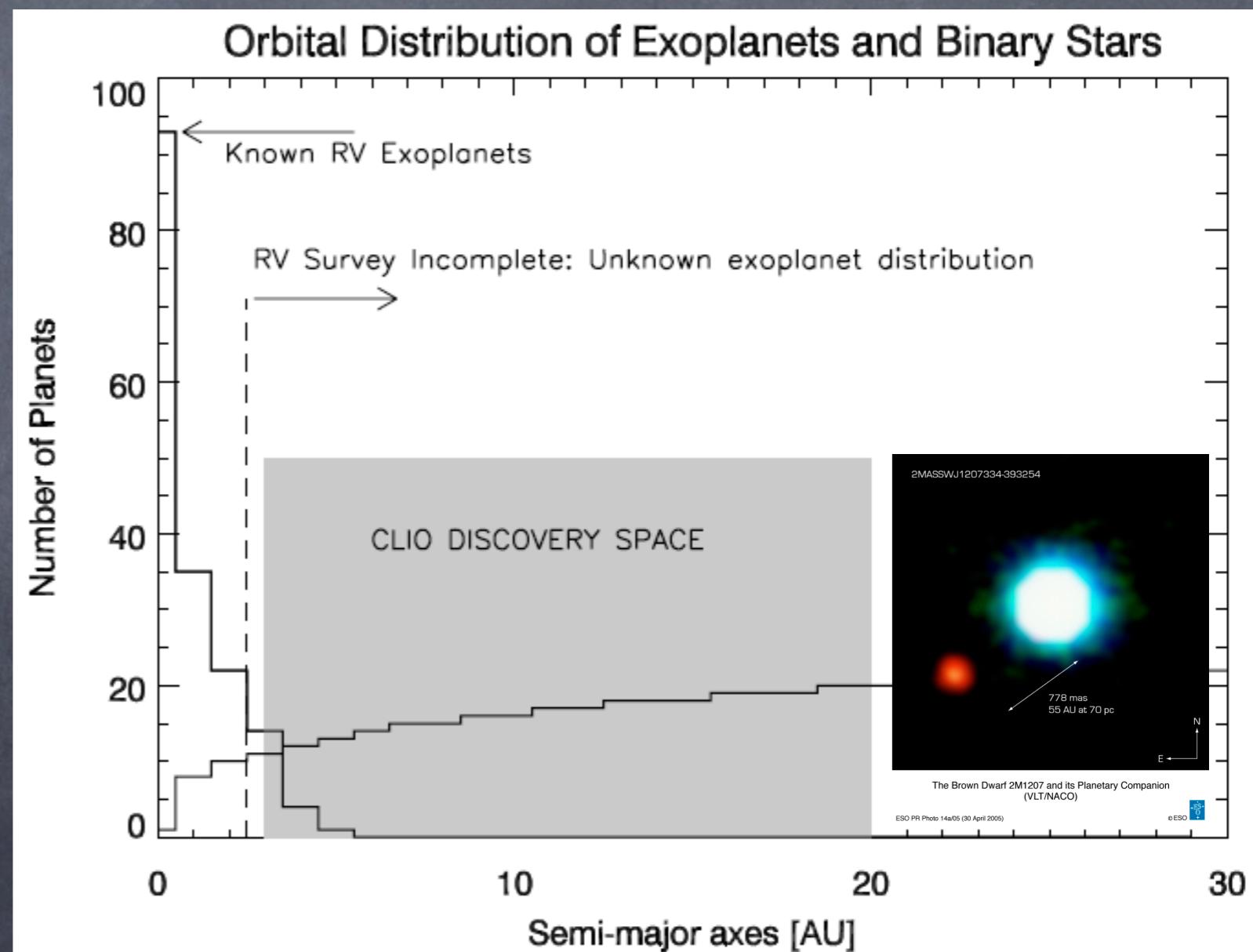
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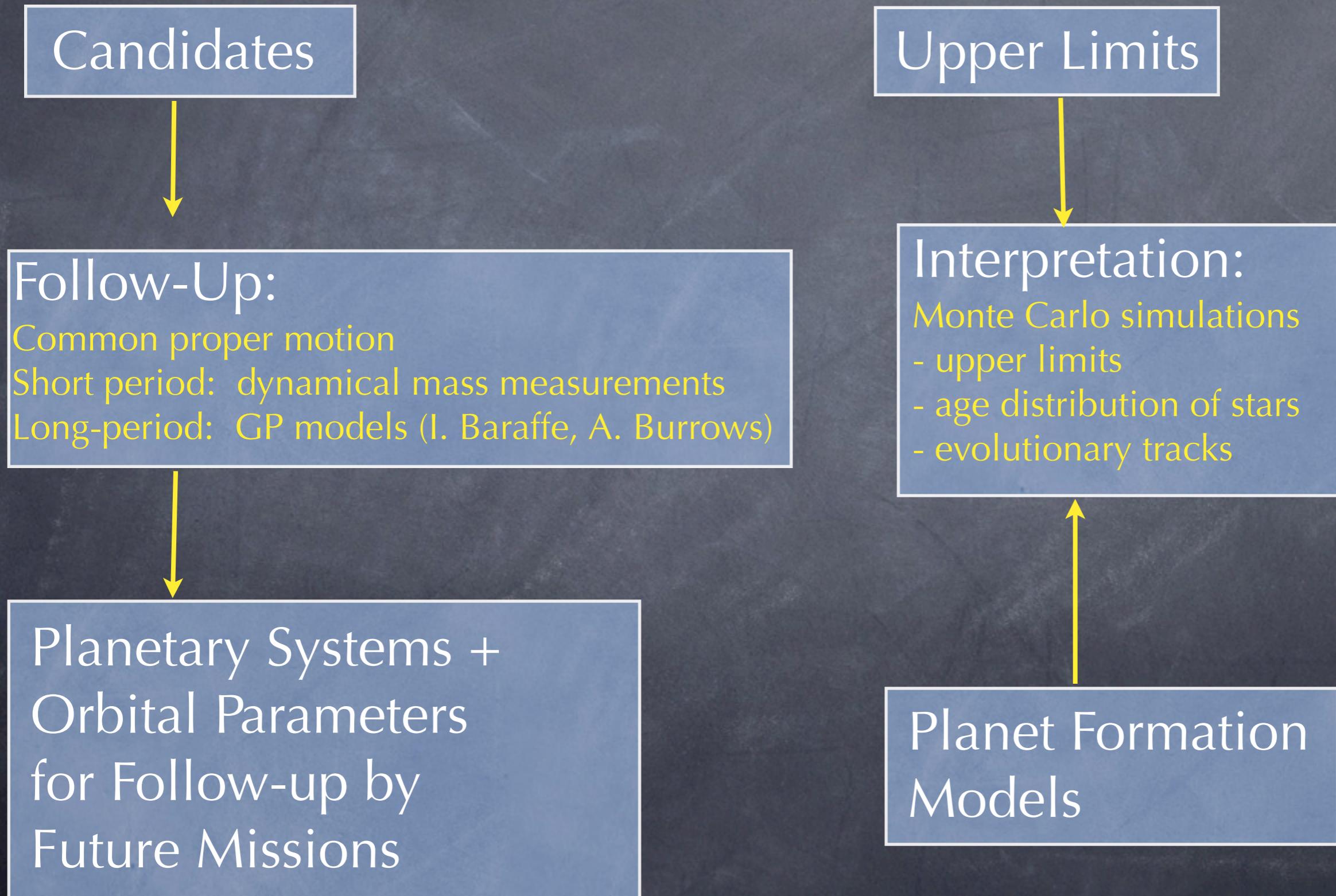
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6pc Survey



Conclusions

MMT/Clio L-band:

some of the most sensitive observations
between 1" and 10"

Young Suns Survey:

Probes 8 - 50 AU for Sun-like stars
complementing the RV surveys

6pc Survey:

Probes 2-30 AU radii for all stars < 6 pc

Search for planets + planetary mass brown dwarfs

Testing planet formation models

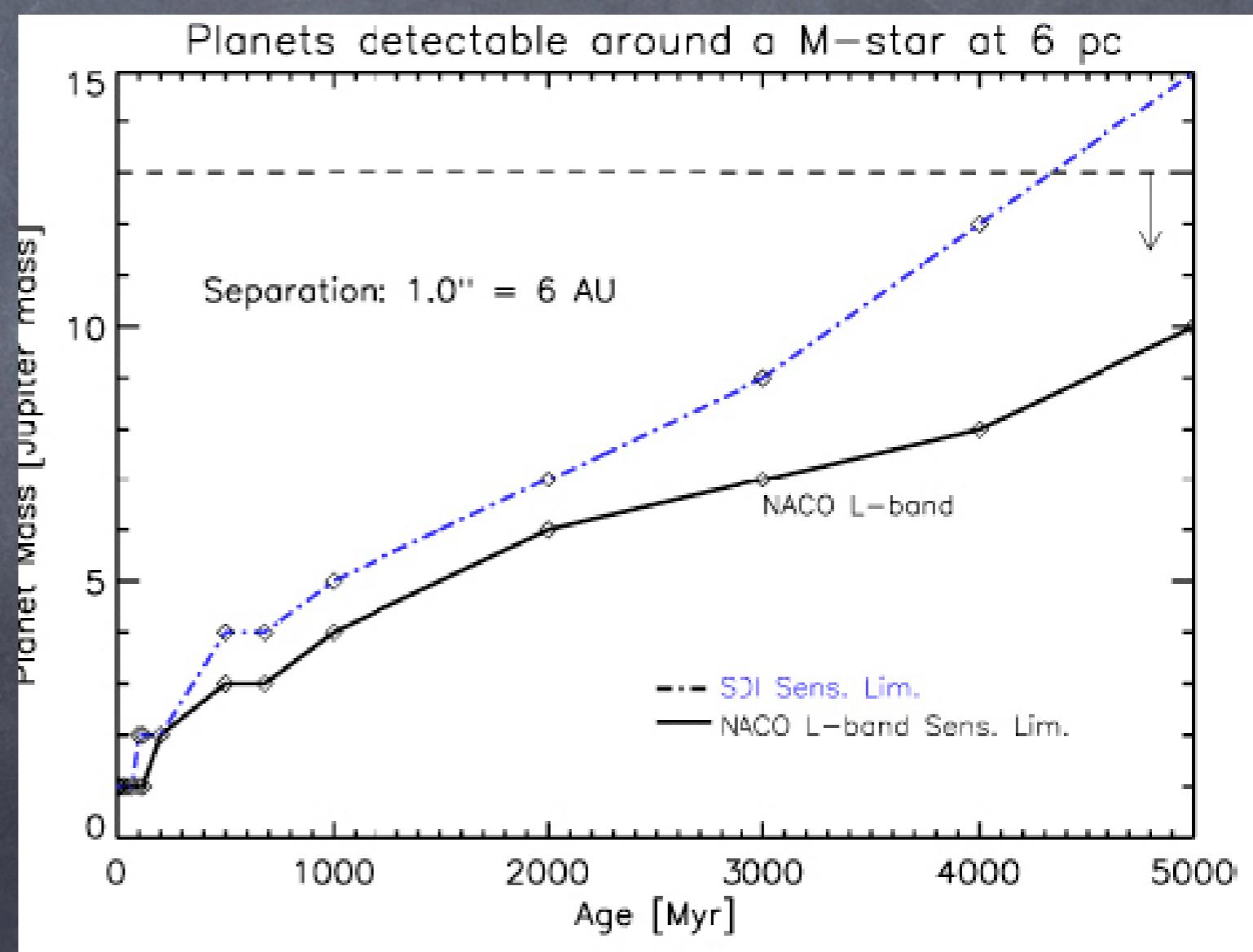
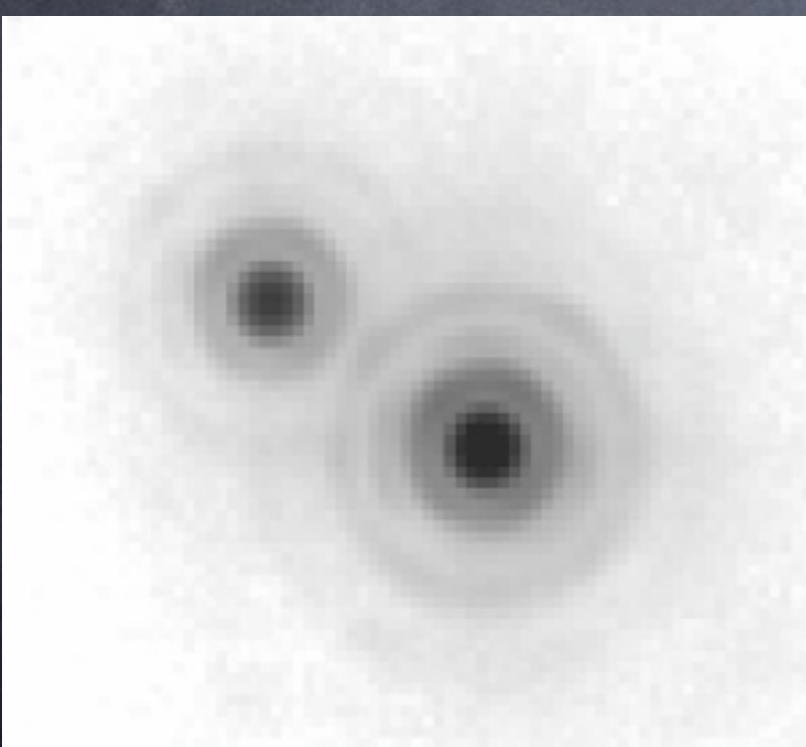
VLT/NACO - The Southern Survey

ADI also possible with NACO

More complex speckle system: double-subtraction necessary

Check out poster from Kasper et al.!

(Kasper, Apai et al. 2005; Kasper et al. 2006)



VLT/NACO - The Southern Survey

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